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10/543,141

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EXAMINER

PADGETT, MARIANNE L

ART UNIT

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PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/543,141	Applicant(s) AIZAWA ET AL.	
	Examiner MARIANNE L. PADGETT	Art Unit 1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 11 September 2009.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-3, 6-8 and 23-33 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-3, 6-8 and 23-33 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

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1. Applicants' amendments of 9/11/2009 have corrected the objections, 112, first & second issues as set forth in sections 2-6 of the action mailed 6/11/2009. Additionally, independent claim 1 has been amended to encompass clarified limitations analogous to those of now canceled claims 4 & 5, but also including specific gas & pulsing limitations as set forth on page 10 of the original specification, with it noted that the requirement of employing repeated voltage pulses was not previously *necessarily* required. These amendments overcome the previously applied rejections, however require further consideration as will be set forth below. Applicants have also added a new independent claims 26, which is essentially a combination of amended claims 1+7+2.

2. The following is a quotation of **35 U.S.C. 103(a)** which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. **Claims 1-3, 6-8, 21 & 23-33** are rejected under under 35 U.S.C. **103(a)** as obvious over **Tachikawa et al.** (EP 0158271 A2), considering **Hirano et al.** (6,780,375 B2) & **Yakabe et al.** (2008/0169049 A1) as teaching references, in view of **Tachikawa et al.** (4,909,862), and further in view of **Naumann et al.** ((DE 19815019 A1), translation ordered, not yet received) &/or **Steinwandel et al.** (6,180,189 B1)

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Tachikawa et al.((EP): abstract; summary on p. 3-4; p. 5, lines 10-21; p. 6, lines 6-25; p. 7, lines 2-29; p. 8, esp. lines 1-5, 9 & 20-28; p. 9, esp. 10-22 & 27-p. 10, lines 7) teach an ion nitriding process that may be applied to Al or Al alloys (e.g. having at least one of Cr, Cu, Mg, Mn, Si, Ni, Fe, Zn, or the like) in a sealed vessel that has had oxygen removed therefrom. The surface of the Al article is heated to a prescribed nitriding temperature & its surface is activated by cleaning processes that remove organic contaminants and alumina from the surface, where ionize discharge via DC or AC (HF) glow discharge may be employed for the cleaning, i.e. removal, hence reading on the claimed sputtering step. Tachikawa et al. (EP) teach that the activating gases may be one or more of He, Ne, Ar, Kr, Xe & Rn, where the heat treatment & activation step may be combined or separate, with further heat treating performed where necessary. The ion nitriding step is preferably performed in a temperature range of 300-500°C to form an AlN layer with high hardness on the surface; may also use DC or AC glow discharge; and employ a nitriding gas, such as N₂ or ammonia or mixed gases of N₂ & H₂. Tachikawa et al. note that if the treating temperature for ion nitriding (e.g. plasma nitriding) is less than 300°C the speed of the nitriding is low, but that treating temperatures above 500°C may cause melting and deformation of the article, as well as spalling during cooling of the aluminum nitride layer produced.

While **Tachikawa et al.** (EP) do not discuss their Al alloys containing CuAl₂, they provide Exs. 3, 4 & 5 that included test processes employing industrial Al alloys JIS 2017 or JIS 6061, where according to **Hirano et al.** (col. 2, lines 9-15 & table 1, sample #13) **JIS 2017** has mass % 0.52 Si, 0.47 Fe, **4.03 Cu**, 0.55 Mn, **0.16 Mg**, 0.01 Cr, 0.01 Zn, **0.01 Ti**, with the balance Al & teachings that Cu contributes improved mechanical strength by forming CuAl₂. Given this teaching of the JIS 2017 alloy composition in employed by Tachikawa et al.(EP) & applicants' p. 8 disclosure of Al alloys having CuAl₂, which showed this alloy has compositional percentages as taught by applicant to form CuAl₂, the examiner takes notice that JS 2017 would contain CuAl₂ as required by independent claims 1 & 26. Also, **Yakabe et al.** (table 1, last entry & [0028]) provide compositional teachings with respect to **JIS 6061**

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having mass % 0.40-0.8 Si, **0.15-0.4 Cu**, **0.8-1.2 Mg**, 0.0 4-0.3 Cr, **<0.15 Ti**, with the balance Al, which also would appear to fit the criteria of applicants' p. 8 alloy listings that have CuAl₂ intermetallics, such that Tachikawa et al. (EP)'s use of JIS 6061 also would appear to read on preparing the required Al material. Note that Tachikawa et al.(EP) need not specifically mention the presence of CuAl₂ precipitates in the alloys used in their process, as they are inherently present in some of alloys employed in their examples.

Tachikawa et al. (EP)'s **Ex. 3** tests both JIS 2017 & JIS 6061, plasma nitriding conditions employing 10 hours to produce a 2.0 μm thick layer (e.g. 0.2 $\mu\text{m/hr}$) & 6 hours to produce a 1.5 μm layer (e.g. 0.25 $\mu\text{m/hr}$). **Ex. 5**, in table 5 on p. 19, the process provides the JIS 2017 sample with a 5.0 μm thick AlN layer of hardness (Hv) 2050 & JIS 6061 a 3.2 μm AlN thick layer with a surface hardness (Hv) of 2100. As HV are in units of kilograms-force per square millimeter, they may be converted to pascals by $1\text{kgf/mm}^2 = 9.80665 \times 10^6 \text{ Pascal}$, thus corresponding to approximately 20 GPa & 20.6 GPa, respectively.

As **Tachikawa et al.** (EP) do not particularly discussed the claimed CuAl₂ intermetallic, there is no discussion of its presence in the resultant AlN surface, however as particularly limiting the plasma nitride processing temperature to avoid melting or deforming the substrate is taught; except for chemical structure changes induced by the ion nitriding, the chemical structure in the surface at the start of the ion nitriding would reasonably have been expected to be maintained, which for the JIS 2017 & JIS 6061 test samples would have included the claimed CuAl₂ intermetallic, especially considering that all temperatures used by Tachikawa et al. (EP) are also employed & claimed by applicants. Alternatively, as it is old and well-known in the metallurgy art that CuAl₂ intermetallics provide strength to Al alloys, it would've been obvious to one of ordinary skill in the art to optimize their nitriding process, such that temperatures employed optimize the maintenance of desirable chemical microstructure in the alloy, which is consistent with Tachikawa et al. (EP)'s temperature teachings.

Tachikawa et al. (EP) do not discuss thermal conductivity values for their produced AlN layer, nor do they discuss the tensile fracture strength at the interface between the AlN & the aluminum alloy substrate, however they do essentially teach to optimize their temperature parameters, so as to avoid spalling of the aluminum nitride layer upon cooling, hence it would've been obvious to one of ordinary skill in the art that the process is intended to be optimized to have good adhesion, such that it would've been expected for the tensile fracture strength at the interface to be not less than that of the substrate material, thus complying with taught desire for the deposited layer not to spall (e.g. flake off), such that resultant tensile fracture strength values would have reasonably been within the claimed range. With respect to thermal conductivity, while no measured values are provided & PTO has no means to measure such values for products of Tachikawa et al. (EP), given like process steps & like materials, like thicknesses, like growth rates, like hardness, it would have been reasonable for one of ordinary skill in the art to expect a thermal conductivity to be inherently the same, as there appear to be no critical differences in the processing steps which could produce significantly different thermal conductivity than the broad open ended claimed range.

With respect to voltage, or voltage & time parameters for the plasma nitriding step, while Takahashi et al. (EP) teach the option of using DC voltage for producing the glow discharge for the ion nitriding process, as illustrated in figure 1; and the claimed nitriding gases with teaching desirable pressures to be used in the process; they do not specify any particular voltage values or ranges, however it would've been obvious to one of ordinary skill in the art, that Takahashi et al.(EP) reasonably expects one of ordinary skill to be able to determine useful voltages via routine experimentation that will produce their taught results, where such experimentation would have reasonably been expected to have yielded negative voltage values within the claimed range, since in order to ion bombard the substrate to cause taught ion nitriding, the metal substrate would have been expected to have a negative charge thereon, where the voltage of that applied negative charge would also have been limited due to the need to keep the nitriding

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temperature within the taught range, since the higher the voltage flowing through the metal substrate, the greater the heat produced therein, as is old and well-known by the competent practitioner in the art.

With respect to claimed voltages employed during the cleaning step, analogous routine experimentation would have been expected, with it additionally was noted that while Tachikawa et al. (EP) only mentioned the possible use of inert gases, it would've been obvious to one of ordinary skill in the art that plasma gasses such as nitrogen, which themselves would not create contaminants in the chamber, would have been obvious to employ in combination or alternatively with the inert gas, with reasonable expectation of providing equivalent sputter cleaning effects, as well as flushing out contaminants in the chamber & removed from the substrate surface, thus providing effective preparation for the nitriding.

Tachikawa et al. (862) provides teachings that are said to be an improvement on prior art USPN 4,597,808 (as discussed in col. 1, lines 38-col. 2, line 6), which appears to be the equivalent of Tachikawa et al. (EP 0158271), thus the teachings in Tachikawa et al. (862) are clearly applicable to the teachings of the European patent primary reference. **Tachikawa et al.** (862) provides teachings that the preparation stage, which cleans organic contaminants & aluminum oxide from the surface, can be accelerated by employing a chemically reactive gas, such as **nitrogen gas** in combination with inert gas (abstract; col. 2, lines 20-27 & 40-55; col. 3, lines 4-col. 4, lines 38, esp. lines 7; samples #1-5 in table 1 & #C2 & C3 in table 2; plus claims 1-7), thus substantiating the above asserted obviousness with respect to N₂ gas, plus providing further motivation for its use it order to perform the plasma nitriding process more efficiently.

Furthermore, in Tachikawa et al. (862)'s Ex. 1, col. 5, lines 47-55, discussed the discharge process with respect to figure 1, indicating anode 12 (e.g. positive electrode) inside heater 10, with the substrate on holder 2 that is the cathode (e.g. negative electrode), where the **DC voltage** applied across the electrodes is several hundred volts, thus substantiating the above asserted negative DC voltage in the claimed ranges applied to the substrate, and further showing the obviousness of claimed parameters, as

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they would have reasonably been expected to have been applied in the exemplary processes of the primary reference.

However, **Tachikawa et al.** ((EP) & (862)) differ from the amended claims as now presented by not discussing use of repeated pulses of voltages, thus not requiring the claimed pulse parameters of -50 V to -50 KV, with ON time of 0.1 μ s-10 ms & OFF time (i.e. suspension of voltage application) of 0.1 μ s-100 ms, however use of pulsed voltages & advantages therefore are known in the plasma art generally, & more specifically in the plasma nitriding art, as shown by **Steinwandel et al.** (abstract; col. 2, lines 25-40 & col. 3) &/or Naumann et al. (DE, English abstracts).

Specifically, **Steinwandel et al.** (6,180,189 B1), with teachings of forming an AlN via high pressure plasmas using microwave radiation or high electric voltages on Al based alloys (e.g. Al₈Si-Cu; AlSi₈Cu, etc.), that nitriding is desirable for its tribological properties & its comparatively high thermal conductivity for a ceramic material; where Steinwandel et al. teach that for both of their Types of taught plasma, either steady-state &/or pulsed discharges may be employed, where use of pulsed discharges is advantageous for allowing a greater variation of plasma parameters to be employed (col. 3, lines 5-28, esp. 23-28). Steinwandel et al. further teach their during plasma nitriding process to first removed native oxides using plasma (col. 3, lines 31-57), and that when using pure N₂, the plasma nitriding processes reaction probability may be increased by adding H₂ (col. 4, lines 12-33, esp. 19-22).

In **Naumann et al.** (two English abstracts, esp. see Derwent (lists inventor as Katzer et al.)), see teachings of plasma nitriding of an aluminum component to form AlN using a plasma process generated by a pulsed DC voltage of 5-50 kHz, which process does not require that one must first cathartically sputter the native oxide, & the Derwent abstract teaches that the process has the advantage of simplifying & shortening the nitriding process, plus having better reproducibility.

It would have been obvious to one of ordinary skill in the art, giving the teachings of Steinwandel et al. &/or Naumann et al. to employ pulsed DC voltage in the plasma nitriding process of Tachikawa et

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al. ((EP) & (862)) discussed above, because either ternary reference shows the expected effectiveness of the pulsed DC plasma for forming aluminum nitride, with Steinwandel et al. specifically mentioning use of alloys & gasses consistent with those taught by Tachikawa et al. (EP, page 5), and providing the advantages of greater parameter adjustability, which one of ordinary skill the art would have found advantageous for optimizing, especially for control of temperature, since it's old and well-known in the plasma art that pulsed plasma is allow for control of temperature, particularly lower temperature processing, that would have been considered advantageous in view of Tachikawa et al. (EP)'s desire to control the temperature. With respect Naumann et al., they specifically suggest that the plasma nitriding process may be shortened & simplified with pulsed plasma, providing motivation to employ pulsed techniques in Tachikawa et al. (EP & 862). However, while Steinwandel et al. & Naumann et al. (abstracts) provide various motivations to employ pulsed DC for the DC plasma of Tachikawa et al. (EP & 862), neither ternary reference provides the set of specific parameters as claimed, but it would've been further obvious to one of ordinary skill in the art to employ routine experimentation to optimize parameters in a particular plasma nitriding apparatus to efficiently effect the taught aluminum nitride surface. It is further noted that Naumann et al. provide some guidance with respect to useful parameters in their teaching desirable pulse frequencies of 5-50 kHz, which while not giving the duty cycle or specific ON/OFF times, gives the total pulse period of 5K-50 K cycle/seconds or $0.2 \text{ ms} - 0.02 \text{ ms} = 200 \mu\text{s} - 20 \mu\text{s}$, thus it would've been further obvious to one of ordinary skill in the art to employ these taught pulsed periods for determining effective duty cycles & voltages to employ therewith to provide effective plasma nitriding at temperatures taught to be required by Tachikawa et al. (EP & 862), which optimize values would have reasonably been expected to be inclusive of claimed parameters, especially considering that claimed ON & OFF times would have encompassed total periods = $(0.1 + 0.1 \mu\text{s} = 0.2 \mu\text{s})$ through $(10 \text{ ms} + 100 \text{ ms} = 110 \text{ ms})$, thus totally encompassing the pulse period of Naumann et al. Also, the examiner notes in the German patent that Naumann

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et al., the German text in col. 3, lines 13-17, is possibly referring to plasma parameters with disclosure concerning 420-1000 V that appear to be at 20 kHz, with "10 % (5 μ s)" possibly referring to duty cycle & ON time, which if so would all be encompassed by applicants' claimed parameters, but with such possible values in conjunction with the English abstracts suggesting a reasonable starting place for routine experimentation, when applying the pulsed discharge teachings to the Tachikawa et al. (EP & 862) process.

4. **New art of interest** includes: **Kim et al.** (English abstract of KR 2001028157) provides further teachings on N-plasma nitriding aluminum & its alloys, where the apparatus employed is described as using a negative plate (substrate holder) & 2 different voltages for first sputter cleaning, then plasma nitriding at appropriate temperatures, with all voltage supplies (HV & LV) being pulsed DC, but the reference provides no specific parameters; and **Hamdi et al.** (5,272,015), who perform nitriding of aluminum by an ion implantation technique, that may use repetitive high-voltage (e.g. ≥ 20 kV) applied to drive in the N^+ .

Yakabe et al. (2008/0169049 A1), noted above as a teaching reference, is also of interest for teachings of plasma nitriding alumina material via relevant pulsed plasma process steps.

Other art of interest previously cited included: **Ohuchi et al.** (4,077,810) with teachings concerning Al alloys that contain Mg & Cu & intermetallic compounds thereof, that are finely precipitated in the matrix as age-hardening elements; **Lin et al.** ((5,248,384): col. 2, lines 25-68) has teachings concerning heating parameters under inert (nitrogen) atmosphere, employed to create Theta phase Al ($CuAl_2$) in Al alloy having Cu content ranging from 0.5-4 %; **Hewitt-Bell et al.** ((6,376,375 B1): col. 5, lines 56-col. 6, line 43) have teachings concerning conditions under which $CuAl_2$ precipitation will occur; **Suzuki et al.** (4,522,660), with early teachings concerning ion plasma nitriding processes of Al or Al alloys; & **Yamaguchi et al.** (JP 63-50456 A), whose English abstract indicates that Al or Al alloy material is treated in an evacuated chamber first with a halogen compound to activate the

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surface in RF glow discharge environment, then subsequently switched to a DC high-voltage source for glow discharge treatment in a nitrogen containing gas to create a hard, black AlN surface film.

5. Applicant's arguments filed 9/11/2009 & discussed above have been fully considered but they are not persuasive.

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

7. **Any inquiry** concerning this communication or earlier communications from the examiner should be directed to **Marianne L. Padgett** whose telephone number is **(571) 272-1425**. The examiner can normally be reached on M-F from about 9:00 a.m. to 5:00 p.m.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks, can be reached at (571) 272-1423. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available

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through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

/Marianne L. Padgett/
Primary Examiner, Art Unit 1792

MLP/dictation software

12/18 & 20/2009